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APOLLO ABORT SUMMARY DOCUMENT

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Preface

The Abort Summary Document has been prepared to provide a single reference source of information and crew procedures *to* be used during S-TB flight nominal, abort, abort reentry, in-flight emergencies, and emergency reentry training. Information contained within this document reflects flight planning in effect at the time of publication.

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Acknowledgments

1) Data used in preparation of the nominal and abort trajectory curves and timelines was furnished by the Flight Analysis Branch of the Mission Planning and Analysis Division.

2) Portions of the Stabilization and Control System (SCS) and the Entry Monitor System (EMS) descriptions were obtained from the Apollo Operations Handbook (AOH).

Table of Contents

1. Apollo Abort Modes

Pad to 61 sec	Mode IA	LET Low Alt
61 sec to 1 min 50 sec	Mode IB	LET Med Alt
1 min 50 sec to 2 min 46 sec	Mode IC	LET High Alt
2 min 46 sec to 9 min 30 sec	Mode II	Full Lift
9 min 30 sec to insertion	Mode III for CSM No Go	SPS Retro Half Lift
9 min 21 sec to insertion	Mode IV for CSM Go	SPS to Orbit
9 min 51 sec to 22 min 39 sec	Fixed ΔV	SPS Retro Halt Lift

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MSC FORM 1131 (OCT 66)

2. Abort Limits

A. Rates and Attitude

1. Pitch and yaw

L/O to T + 50 seconds	3° per second $\pm 5^{\circ}$ total attitude error pitch or yaw axis and increasing*
T + 50 **to** Staging	5° per second
Staging to SECO	10° per second

(Excluding staging: 2 min 26 sec to 2 min 31 sec)

2. Roll

L/O to SECO	20° per second

B. Max q Region - The following limits represent single cues and are restricted to the time period from 50 seconds to **1** minute 40 seconds. Abort action should be taken only after both have reached threshold.

1. Angle of attack - 100 percent

2. Roll error - 12 degrees (use FDAI roll index "bug")

C. Automatic Abort Limits (L/O until deactivate **1** + 40)

1. Rate	pitch - yaw	$5.0 \pm .5^{\circ}$ per second
	roll	$20.0 \pm .5^{\circ}$ per second

2. Any two engines out

NOTE: Between L/O and 1 + 40, switch TWO ENG OUT AUTO to OFF following confirmation of **ONE** ENG OUT.

3. CM to I.U. breakup

D. Engine Failure (L/O to IECO)

1. One engine out	Continue Mission
2. Simultaneous loss two **or** more engines	Abort
3. Second engine loss following confirmation of one engine out	Continue Mission

E. **S-IVB** Tank Pressure Limits (L/O to CSM/LV Sep)

AP $LH_2 > LO_2 = 24$ PSID

$LO_2 > LH_2 = 30$ PSID

* Attitude errors are not displayed from lift-off until T + 10 seconds.

3. Nominal Launch Phase Voice Callouts

Time	Station	Callouts
-0:03	LCC	Report Ignition
0:00	LCC & A	Lift-off
0:01	A	Clock Start
0:10	A	Roll Frcgram
0:21	A	Pitch Program
0:38	A	Roll Complete .
0:50	MCC	Rate Change
0:61	A	Mode IB (PRPLNT Dump to RCS CMD)
1:40	A	EDS, Rates, and Eng Auto OFF
1:50	MCC	Mark Mode IC (h=16.5 n.m. on DSKY)
2:10	MCC	Go/No Go for Staging (TWR JETT Update Time if Required)
2:23	A	Inboard Cutoff
2:26	A	Outboard Cutoff
2:27	A	Staging
2:31	A	Ignition
2:35	A	RATE: 50/10
2:40	MCC	Trajectory Go/No Go, CDR: GIMBAL MTRS ON
2:46	A	Tower Jettison (J-2 + 15), then RATE CMD
3:10	A	Guidance Initiate
4:00	A	CMP: S/C Go/No Go
4:30	MCC	Trajectory Status
5:00	A	LMP: S/C Go/No Go
6:00	A	CDR: S/C Go/No Go
7:00	A	CMP: S/C Go/No Go
8:00	A	LMP: S/C Go/No Go
9:00	MCC	Trajectory Status, CDR: S/C Go/No Go
	A	CDR: S/C Go/No Go
9:21	MCC	Mark Mode IV
9:51	MCC	Fixed AV Mode
9:53	A	SECO
10:00	A	$\dot{h}$, h_a, h_p (N62, N44)

P11 Displays
N62: Vi, $\dot{h}$, h
N44: h_a, h_p, t_{ff}
N35: T_{per} (HRS, MINS, SECS)

Note: Switching functions underlined

4. EDS Displays Definitions

The EDS is designed to provide onboard decision capability for rapidly diverging rate malfunctions which may require abort. In the event of a discrepancy between onboard and ground based instrumentation, onboard data will be used except for slow rate guidance deviations.

Pilot abort action must in all cases be based upon TWO valid and related abort cues. These cues may be derived from the EDS displays, ground information, physiological cues, or any combination of two valid cues.

A. EDS Displays

(Display Panel, Page 65)

1. Flight Director Attitude Indicator (FDAI)

The FDAI provides indications of launch vehicle attitude, attitude rates, and attitude errors, except that attitude errors will not be displayed during S-IVB flight.

Excessive pitch, roll, or yaw indications provide a single cue that an abort is required. Additional abort cues will be provided by the FDAI combining rates, error, or total attitude. Second cues will also be provided by the LV rate light, guidance fail light, physiological., and MCC-H ground reports.

The FDAI will be used to monitor normal launch vehicle guidance and control events. The roll and pitch programs are initiated simultaneously at + 10 seconds. The roll program is terminated at 72° azimuth (38 seconds) and the pitch program continues throughout first stage flight. Guidance initiate will occur at approximately 3 minutes 10 seconds (OCO + 44 seconds).

2. FDAI Rate and Display Select Switches

A. FDAI Scale:

Position	Function	
	Error	Rate
UP	5	1
CENTER	5	5
DOWN	50/15	50/10

Error indications are displayed for this mission between T + 10 seconds and T + 2 minutes 13 seconds. During that time, roll errors are usable on the 50/15 scale only. Since the 5/5 scale adapts more readily to this mission's early abort limits, it is planned to lift-off with the 5/5 scale and switch to the larger scale after J-2 ignition. During the maximum dynamic pressure region where roll errors can be critical, the roll bug can adequately serve as a total roll error indication for abort limit monitoring.

B. FDAI Select: Select either or both FDAI's

C. FDAI Source: Selects the source of signals displayed on the FDAI.

Position	Function	Description
UP	CMC	Displays IMU gimbal angles on the ball. Displays CDU error generation on error needles.
CENTER	ATT SET	Displays difference between ATT SET dial and total attitude reference selected by ATT SET switch.
DOWN	GDC	Displays GDC angles on the ball. Displays BMAG error on error needles.

3. LV Engine Lights

The eight LV engine lights ON indicate that each corresponding S-IB stage engine is below 90 percent nominal thrust. The engine light cluster also provides indications of the launch vehicle staging sequence. Physical separation of stages is indicated with all engine lights OFF (after normal S-IB cutoff). The No. 1 light will come ON with the S-IVB engine ignition command and will go OFF when the S-IVB engine exceeds 65 percent nominal thrust. For abort decisions the ON indication is considered zero thrust for the corresponding engine and OFF is 100 percent thrust. Each S-IB engine light and sensing circuit is redundant and constitutes a single "warning" cue of a possible abort situation.

If an engine light illuminates during first stage flight, the following actions are applicable as the situation dictates:

a. Report failure indication and await ground confirmation and instructions.

b. If T >+ 15 seconds, deactivate TWO ENGINE, OUT AUTO ABORT switch after confirmation from ground that the engine is out.

c. If a second. engine status light illuminates simultaneously or within a very short time of the first light so as to suggest a sympathetic failure, ABORT immediately. This suggests a hazardous environment.

d. If a second engine status light illuminates after ground confirmation of the first engine failure, continue mission and await confirmation and instructions.

"he Saturn IB vehicle has a limited capability to continue the mission with loss of one or two engines, depending upon the time of the failure(s). Mission rules will prescribe the performance timelines after which flight may be continued with one and two engines cut.

During S-IVB burns the No. 1 engine light ON is a single abort cue. Loss of acceleration is the obvious second cue for an immediate abort.

4. LV Rate Light

The LV rate light ON is the primary cue from the launch vehicle that preset overrate settings have been exceeded. It is a single cue for abort, while secondary cues will be provided by FDAI indications, physiological cues, or ground information.

Automatic LV rate aborts are enabled automatically at lift-off (with EDS and LV RATE: AUTO switches enabled in SC) and are active until deactivated by the crew. EDS auto abort deactivation times will be governed by mission rules. The automatic LV rate abort capability is also deactivated by the launch vehicle sequencer prior to inboard engine cutoff and is not active during S-IVB flight.

The overrate settings are constant throughout first stage flight. They are:

Pitch and yaw	5°/second $\pm$ 0.5°/second
Roll	20°/second $\pm$ 0.5°/second

For second stage flight they are:

Pitch and yaw	10°/second $\pm$ 0.5°/second
Roll	20°/second $\pm$ 0.5°/second

The rate light will come ON at any time during first or second stage flight if the LV rates exceed these values.
NOTE: The LV rate light may blink ON and OFF during normal staging.

5. LV Guidance Light

The LV platform is interrogated every 25 milliseconds for the correct attitude. If an excessive attitude discrepancy is found during three consecutive checks on the fine resolvers, three more checks will be performed on the coarse resolvers. (The LV can continue the mission on the coarse resolvers alone.) If they too fail (exceed 15°/second rate of attitude change in any plane), commands sent to the control system to change LV attitude will be inhibited and the control system will hold the last acceptable control command.

A signal is sent from the LVDA to activate the LV Guid light in the CM at the same time the control commands are inhibited, It is a single cue for abort. Second cues will be provided by the FDAI, AOA, and/or ground information.

6. LIFT-OFF/NO AUTO ABORT Lights

The LIFT-OFF and NO AUTO ABORT are independent indications contained in one switch/light assembly.

The LIFT-OFF light ON indicates that vehicle release has been commanded and that the IU umbilical has ejected. The SC digital event timer is started by the same function. The lift-off light is turned OFF at nominal inboard engine cutoff.

The NO AUTO ABORT light ON indicates that one or both of the spacecraft sequencers did not enable automatic abort capability at lift-off. Automatic abort capability can be enabled by pressing the light push button. If tha light remains ON, then the crew must be prepared tc back up the automatic abort manually. The no auto abort light is also turned OFF at inboard engine cutoff.

WARNING

If the NO AUTO ABORT push button is depressed at T-0 and a pad shutdown should occur, a pad abort will result.

7. ABORT Light

The ABORT light may be illuminated by ground command from the flight director, the MCC booster systems engineer, the MCC tank pressure monitor, the flight dynamics officer, the Complex 34 launch director (until tower clearance at + 10 seconds) or in conjunction with Range Safety booster engine cutoff and destruct action. The ABORT light ON constitutes one abort cue. An RF voice abort request constitutes one abort cue.

For a large percentage of time-critical launch vehicle malfunctions, particularly at lift-off and staging, pilot abort action will be required prior to receipt of an abort request light and voice command.

8. Angle of Attack (qa)

The angle of attack meter is time shared with SPS chamber pressure. The qa display is a pitch and yaw vector summed angle of attack/dynamic pressure product. It is expressed in percentage of total pressure for predicted launch vehicle breakup (abort limit equals 100 percent). It is effective as an abort parameter only during the high q flight region from + 50 seconds to + 1 minute 40 seconds.

Except as stated above, during ascent, the AOA meter provides trend information on launch vehicle flight performance and provides a secondary cue for slow rate guidance and control malfunctions. Primary cues for guidance and control malfunctions will be provided by the FDAI, physiological. cues, and/or MCC-H callout.

Nominal angle of attack meter indications should not exceed 25 percent. Expected values based on actual winds aloft prior to launch will be provided by MCC-H prior to launch.

9. Accelerometer

The accelerometer indicates longitudinal acceleration/decelerations. It provides a secondary cue for certain engine failures and is a gross indication of launch vehicle performance. The accelerometer also provides a readout of G-forces during reentry.

10. Altimeter

Due to dynamic pressure, static source location, and instrument error, the altimeter is not considered to be an accurate instrument during the launch phase.

The primary function of the altimeter is to provide an adjustable (set for barometric pressure on launch date) reference for parachute deployment for pad/near pad LES aborts. However, the aerodynamic shape of the CM coupled with the static source location produces errors up *to* 1800 feet. Therefore, the main parachutes must be deployed at an indicated 3800 feet (depends on launch day setting) *to* insure deployment at 2000 feet true altitude.

11. Event Timer

The event timer is critical because it is the primary cue for the transition of abort modes, manual sequenced events, monitoring roll and pitch program, staging, and S-IVB insertion cutoff. The event timer is started by the lift-off command which enables automatic aborts. The command pilot should be prepared to manually back up its start to assure timer operation.

The event timer is reset to zero automatically with abort initiation.

12. MASTER ALARM Light

The MASTER ALARM light ON alerts the flight crew to critical spacecraft failures or out-of-tolerance conditions identified in the caution and warning light array. After extinguishing the alarm light, action should be initiated to correct the failed or out-of-tolerance subsystem. If crew remedial action does not correct the affected subsystem, then an abort decision must be made based upon contingencies. In many cases remedial action will correct the malfunctioned/out-of-tolerance subsystem. Secondary abort cues will come from subsystem displays, ground verification, and physiological indications. The commander's alarm light will not illuminate during the launch phase. The alarm tone is not affected.

B. EDS Controls

1. Translational Controller

Manual aborts will be commanded by counterclockwise (CCW) rotation of the translational controller T-handle. Clockwise (CW) rotation will transfer SC control from the CMC to the SCS system.

For U S aborts the CCW position sends redundant engine cutoff commands (engine cutoff from the SC is inhibited for the first 40 seconds of flight) to the launch vehicle, initiates CM/SM separation, fires the US Motors, resets the sequencer, and initiates the post abort sequence.

For SPS aborts the CCW rotation commands LV engine cutoff, resets the spacecraft sequencer, and initiates the CSM/LV separation sequence.

The T-handle also provides CSM translation control along one or more axes. The control is mounted approximately parallel to the SC axis, therefore, T-handle movement will cause corresponding SC translation. Translation in the +X axis can also be accomplished by use of the direct ullage push button; however, rate damping is not available when using the backup method.

2. EDS AUTO

The EDS AUTO switch is the master switch for EDS initiated automatic aborts. When placed in the AUTO position (normally prior to lift-off) an automatic abort will be initiated if:

a. An LV structural failure occurs between the IU and the CSM.
b. Two or more S-IB engines drop below 90 percent rated thrust.
c. LV rates exceed 5°/second in pitch or yaw or 20°/second in roll.

The TWO ENGINE OUT and LV RATE portions of the auto abort system can be manually disabled individually by the crew. However, they are automatically disabled by the LV sequencer prior to ICO.

According to mission rules the deactivation time for the EDS AUTO switch is T + 1 minute 40 seconds. All aborts after this time will be manually initiated.

3. PRPLNT DUMP AUTO/RCS CMD Switch

This switch is normally in the OX **DUMP** AUTO position prior to lift-off in order to automatically dump the CM RCS propellants and fire the PC motor if an abort is initiated duringthe first 61 seconds of the mission. The propellant dump and PC motor are inhibited by the SC sequencer at 61 seconds. The switch in the RCS CMD position will inhibit Ox dump and PC motor firing at **any** time.

4. TWR JETT Switches

Either of two redundant switches can be used to fire the explosive bolts and the tower jettison motor, The appropriate relays are also deenergized so that if an abort is commanded, the SPS abort sequence and not the LES sequence will occur. The switches are momentary to the TWR JETT position. Both switches should be activated to insure that redundant signals are initiated.

No other automatic functions will occur upon activation of the tower jettison switches.

5. CM/SM SEP Switches

Redundant momentary ON guarded switches, spring loaded to the **OFF** position, are used by the command pilot to accomplish CM/SM separation when required. *Both* switches should be activated to insure that redundant signals are initiated.

These switches can also be used to initiate an LES abort in case of a failure in either the EDS or the translational controller. All normal post abort events will then proceed automatically. However, the canard deploy push button should be depressed 11 seconds after abort initiation because canard deployment and subsequent events will not occur if the failure was in the EDS instead of the translational controller. If the canard deploy push button is depressed, all automatic functions from that point on will proceed normally.

6. ELS AUTO/MANUAL

The Earth Landing System (ELS) AUTO switch is used in conjunction with either the automatically initiated ELS sequence {post abort) or with the manually initiated sequence (ELS LOGIC ON). It is normally in the AUTO position at all times as it will inhibit all ELS functions when in the MANUAL position.

7. ELS LOGIC Switch

The ELS LOGIC switch is a guarded switch. It should only be activated during normal reentry or following an SPS abort, and then only below 45,000 feet altitude. If activated at any time below 30,000 feet (pressure altitude), the landing sequence will commence, i.e., LES and apex cover jettison and drogue deployment. If activated below 10,000 feet altitude, the main chutes will also deploy. It is, therefore, imperative that this switch be in the OFF position during prelaunch and launch operations.

ELS logic is automatically enabled following any manual or auto EDS initiated. LES abort. It should be manually backed up 5.f time permits.

WARNING

Activation of ELS LOGIC switch below 30,000 feet altitude will initiate landing sequence, i.e., LES and. apex cover jett, drogue deploy, etc.

8. CM RCS PRESS

Any time the CM is to be separated from the SM, the CM RCS must be pressurized. The normal sequence of events for an abort or normal CM/SM SEP is to automatically deadface the umbilicals, pressurize the CM RCS and then separate the CM/SM. However, if the automatic pressurization fails, the CM RCS can be pressurized by the use of the guarded switch located on panel 2.

9. MAIN CHUTE RELEASE

The main chute release switch is a guarded switch. It is used to manually release the main chutes after the Command Module has landed. No automatic backup is provided. This switch is armed by the ELS LOGIC switch ON and the 10K barometric switches closed (below 10,000 feet altitude).

NOTE: The ELS AUTO switch must be in the automatic position to allow the 14 second timer to expire before the MAIN CHUTE RELEASE switch will operate.

10. Sequencer Event Manual Push Buttons

The LES MOTOR FIRE, CANARD DEPLOY, CSM/LV SEP, APEX COYER JETT, DROGUE DEPLOY, MAIN DEPLOY, and CM RCS He DUMP push buttons provide backup of sequenced events for both abort and normal reentry situations.

The MAIN DEPLOY push button is the primary method of deploying the main parachutes for pad/near pad aborts to assure terminal velocity at touchdown (downrange tipover).

C. SPS Switches and Displays

1. DIRECT ULLAGE Push Button

When the button is depressed, a +X translation utilizing all four quads results. It is the backup method for ullage maneuvers prior to an SPS burn (the prime method for ullage is the translational controller). The DIRECT ULLAGE switch is momentary and must be held until ullage is complete. It will *not* give rate damping, however, since the automatic coils are disengaged.

2. THRUST ON Push Button

The THRUST ON push button can be used to start the SPS engine under the following conditions:

a. S/C control is in the SCS Mode
b. Ullage is provided
c. ΔV THRUST switches (either of two) are in the NORMAL position
   NOTE: Both must be OFF *to* shut off the engine
d. As a backup to a G&N generated start command

The SPS engine can be shut off (when fired as described above) in the following manner:

a. FCSM shuts it down automatically
b. $\Delta V = 0$ (SCS or MTVC)
c. ΔV THRUST switches (both) OFF

The SPS THRUST light located in the EMS will illuminate when the engine is firing.

3. SPS THRUST DIRECT ON/NORMAL

The switch is a two position lever lock toggle type. The ON position provides a ground for the solenoid valve power and all of the SCS logic. The engine must be turned off manually by removing prevalve power as no automatic shutoff exists. The AV THRUST switches must be in the NORMAL position (at least one) to apply power to the solenoids for the SPS THRUST DIRECT switch to operate.

WARNING

The SPS THRUST DIRECT switch is a single point failure when the AV THRUST switches are in the NORMAL position.

4. SPS Gimbal Motors/Indicators

There are four gimbal motors used to control the SPS engine position in the pitch and yaw planes (two in each plane). These motors are activated by four switches located on panel 1. The motors should be activated one at a time due to excessive current drain during the start process.

The gimbal thumbwheels can be used to position the gimbals to the desired attitude as shown on the indicators. The indicators are analog displays time shared with the booster fuel and oxidizer pressure readings. The desired display can be selected by the switch located at the bottom of panel 1.

The other methods of controlling the gimbal movement are through the hand controller in the MTVC Mode or by automatic SCS logic.

5. ΔV THRUST (Prevalves & Logic)

The two guarded switches apply power to the SPS solenoid prevalves and to the SCS logic for SPS ignition. These switches must be on (NORMAL) before the SPS engine can be started -- even by the SPS THRUST DIRECT switch.

WARNING

Either switch enabled will enable engine start, however, both must be OFF to stop the engine.

6. SCS Thrust Vector Control (TVC)

These switches are active only in the SCS Mode.

Pitch and yaw channels can be used independently; i.e., pitch control could be in SCS automatic and yaw in MTVC. The three available modes are:

a. Auto: The TVC is directed by the SCS electronics
b. Rate CMD: MTVC with rate damping included
c. Acceleration CMD: MTVC without rate damping

7. ΔV and ΔV SET Switches

In order for the ΔV counter to operate during an SPS burn, the switches located on the EMS panel must be in the following positions:

a. EMS MODE - AUTO
b. EMS FUNCTION - AV

To set the ΔV counter for a desired ΔV burn the switches would be as follows:

a. EMS MODE - AUTO
b. EMS FUNCTION - ΔV SET

The five position ΔV SET slew switch is then used to place the desired quantity on the ΔV display.

D. SCS System Switches

1. SCS CHANNEL Switches

These switches are used to apply power to or remove power from the RCS Control Box assembly. Power is also removed from the attitude control logic by these switches, thereby deleting all automatic attitude hold and/or maneuvering capability using SCS electronics. The Direct solenoids are not affected as all SCS electronics are bypassed by activation of the DIRECT **RCS** switch (manual control).

NOTE: The automatic solenoids cannot be activated until the RCS enable is activated either by the MESC or manually.

2. DIRECT RCS Switch

The DIRECT RCS switch provides manual control of the SM RCS engines. The control is achieved by positioning the rotation control hardover to engage the direct solenoids for the desired axis change.

All SCS electronics are bypassed when this switch is activated.

3. ATT SET Switch

Selects the source of total attitude for the ATT SET resolvers.

Position	Function	Description
UP	IMU	Applies IMU gimbal resolver signal to ATT SET resolvers. FDAI error needles display difference. Needles are zeroed by maneuvering SC or by moving the ATT SET dials.,
DOWN	GDC	Applies GDC resolver signal to ATT SET resolvers. FDAI error needles display differences resolved into body coordinates. Needles zeroed by moving SC or ATT SET dials. New attitude reference is established by depressing GDC ALIGN button. This causes GDC to drive to null the error; hence, the GDC and ball go to ATT SET dial value.

4. MANUAL ATTITUDE Switches

These three switches (ROLL, PITCH, and YAW) are only operative when the SC is in the SCS Mode of operation.

Position	Description
ACCEL CMD	Provides direct RCS firing as a result of moving the rotational controller out of detent (2.5°) to apply direct inputs to the solenoid driver amplifiers.
RATE CMD	Provides proportional rate command from rotational controller with inputs from the BMAG's in a rate configuration.
MIN IMP	Provides minimum impulse capability through the rotational controller.

5. LIMIT CYCLE

The pseudo-rate function provides the capability of maintaining low SC rates while holding the SC attitude within the selected deadband limits (limit cycling). This is accomplished by pulse-width modulation of the switching amplifier outputs. instead of driving the SC from limit-to-limit with high rates by firing the RCS engines all the time, the engines are fired in "spurts" proportional in length and repetition rate to the switching amplifier outputs.

Extremely small attitude corrections could be commanded which would cause the pulse-width of the resulting output command to be of too short a duration to activate the RCS solenoids. A "one-shot" multivibrator is connected in parallel to insure a long enough pulse to fire the engines.

6. RATE and ATT DEADBAND Switches

The switching amplifier deadband can be interpreted as a rate or an attitude (minimum) deadband. The deadband limits are a function of the RATE switch. An additional deadband can be enabled in the attitude control loop with the ATT DEADBAND switch.

RATE Switch Position	Rate Deadband °/sec	ATT DEADBAND Switch Position Min	Max
LOW	±0.2	±0.2°	±4.2°
HIGH	±2.0	±4.0°	±8.0°

The rate commanded by a constant stick deflection (Proportional Rate Mode only) is a function of the RATE switch position. The rate commanded at maximum stick deflection (soft stop) is shown below:

RATE Switch Position	Maximum Proportional Rate Command Pitch and Yaw	Roll
LOW	0.65°/sec	0.65°/sec
HIGH	7.0 °/sec	20.0 °/sec

7. S/C CONTROL (Source)

Position	Description
CMC	Selects the G&N system - computer controlled SC attitude and TVC through the digital autopilot. An autopilot control discrete is also applied to CMC.
SCS	The SCS system controls the SC attitude and TVC.

8. BMAG MODE - ROLL, PITCH, and YAW

Selects displays for the FDAI using SCS inputs.

Position	Description
RATE 2	BMAG Set No. 2 provides the rate displays on the FDAI. There is no BMAG attitude reference availabie,
ATT 1/ RATE 2	BMAG Set No. 1 provides attitude reference on the FDAI, while Set No. 2 provides the rate display.
RATE 1	BMAG Set No. 1 provides the rate displays on the FWI. There is no BMAG attitude reference available.

9. EMS ROLL Switch

This switch enables the EMS roll display for the earth reentry phase of the flight.

10. 0.05 G Switch

Illumination of the 0.05 G switch located on the EMS panel is the cue for the crew to actuate the 0.05 G switch. During atmospheric reentry (after 0.05 G), the SC is maneuvered about the stability roll axis rather than the body roll axis. Consequently, the yaw rate gyro generates an undesir e sig l. By c aw channel, the a component of the roll signal into t able signal is cancelled. The 0.05 G switch performs this coupling function.

11. GUID - IU/CMC

When placed in the CMC position the appropriate relays are energized to disconnect the LVDC from, and connect the CDU's to, the S-IVB control computer. If the proper program is then called up on the DSKY, the CDR can control the vehicle with the RHC. However, the maximum commanded rates possible are:

Orbit phase (after TB4)

0.3°/second in pitch and yaw
0.5°/second in roll.

E. EMS Displays

1. Threshold Indicator (0.05 G Light)

This indicator provides the first visual indication of total acceleration sensed at the reentry threshold (approximately 290,000 feet). Accelerometer output is fed to a comparison network and will illuminate the 0.05 G lamp when the acceleration reaches 0.05 G. The light will come on not less than 0.5 seconds or more than 1.5 seconds after the acceleration reaches 0.05 G and turns off when it falls below 0.02 G (skipout).

2. Corridor Indicators

By sensing the total acceleration buildup over a given period of time, the reentry flight path angle can be evaluated. This data is essential to determine whether or not the entry angle is steep enough to prevent superorbital "skipout".

The two corridor indicator lights are located on the face of the roll attitude indicator (bottom left-hand corner of the EMS panel).

If the acceleration level is greater than 0.2 G at the end of a ten second period after threshold (0.05 G light ON), the upper light will be illuminated. It remains ON until the G-level reaches 2 G's and then goes OFF. The lower light illuminates if the acceleration is equal to or less than 0.2 G at the end of a ten second period after threshold. This indicates a shallow entry angle and that the lift vector should be down for controlled entry, i.e., skipout will occur.

3. Roll Stability Indicator

This indicator provides a visual indication of the roll attitude of the CM about the stability axis. Each revolution of the indicator represents 360° of vehicle rotation. The display is capable of continuous rotation in either direction,. The pointer up position (0°) indicates maximum lift-up vector (positive lift) and pointer down (180°) indicates maximum lift-down vector (negative lift).

4. G-V Plotter

The G-V plotter assembly consists of a scroll of mylar tape and a g-indicating stylus. The tape is driven from right to left by pulses which are proportional to the acceleratian along the velocity vector. The stylus which scribes a coating on the back of the mylar scroll, is driven in the vertical direction in proportion to the total acceleration.

The front surface of the mylar scroll is imprinted with patterns consisting of "high g rays" and "exit rays". The "high g rays" must be monitored from initial entry velocity down to 4000 feet per second. The "exit rays" are significant only between the entry velocity and circular orbit velocity and are, therefore, only displayed on that portion of the pattern.

The imprinted "high g rays" and "exit rays" enable detection of primary guidance failures of the type that would result in either atmospheric exits at supercircular speeds or excessive load factors at any speed. The slope of the G-V trace is visually compared with these rays. If the trace becomes tangent to any of these rays, it indicates a guidance malfunction and the need for manual takeover,

5. EMS FUNCTION Switch

This control has a 12 position EMS FUNCTION switch located in the upper left-hand area of the EMS panel.

a. The first three positions starting at ΔV and rotating clockwise are used during the ΔV mode as follows:

Switch Position	Description
ΔV	Operational mode for monitoring ΔV maneuvers
ΔV Set	Establish circuitry for slewing ΔV counter for self test or as operational
ΔV Test	Operational mode for self test of the ΔV subsystem

b. The nine positions starting at the No. 1 position and rotating counterclockwise are used for self tests and the entry mode as follows:

Switch Position	Description
No. 1	Tests lower trip point of 0.05 G threshold comparator
No. 2	Tests higher trip point of 0.05 G threshold comparator
No. 3	Tests lower trip point of corridor verification comparitor
No. 4	Tests velocity integration circuitry, g-servo circuitry, G-V plotter, and the range-to-go subsystem
No. 5	Test higher trip point of corridor verification comparitor
RNG Set	Establish circuitry for slewing range-to-go counter for operational and test modes
Vo Set	Establish circuitry for slewing G-V plotter scroll for operational mode
Entry	Operational mode for monitoring entry mode
OFF	Turns off all power except to the SPS thrust light and to switch lighting

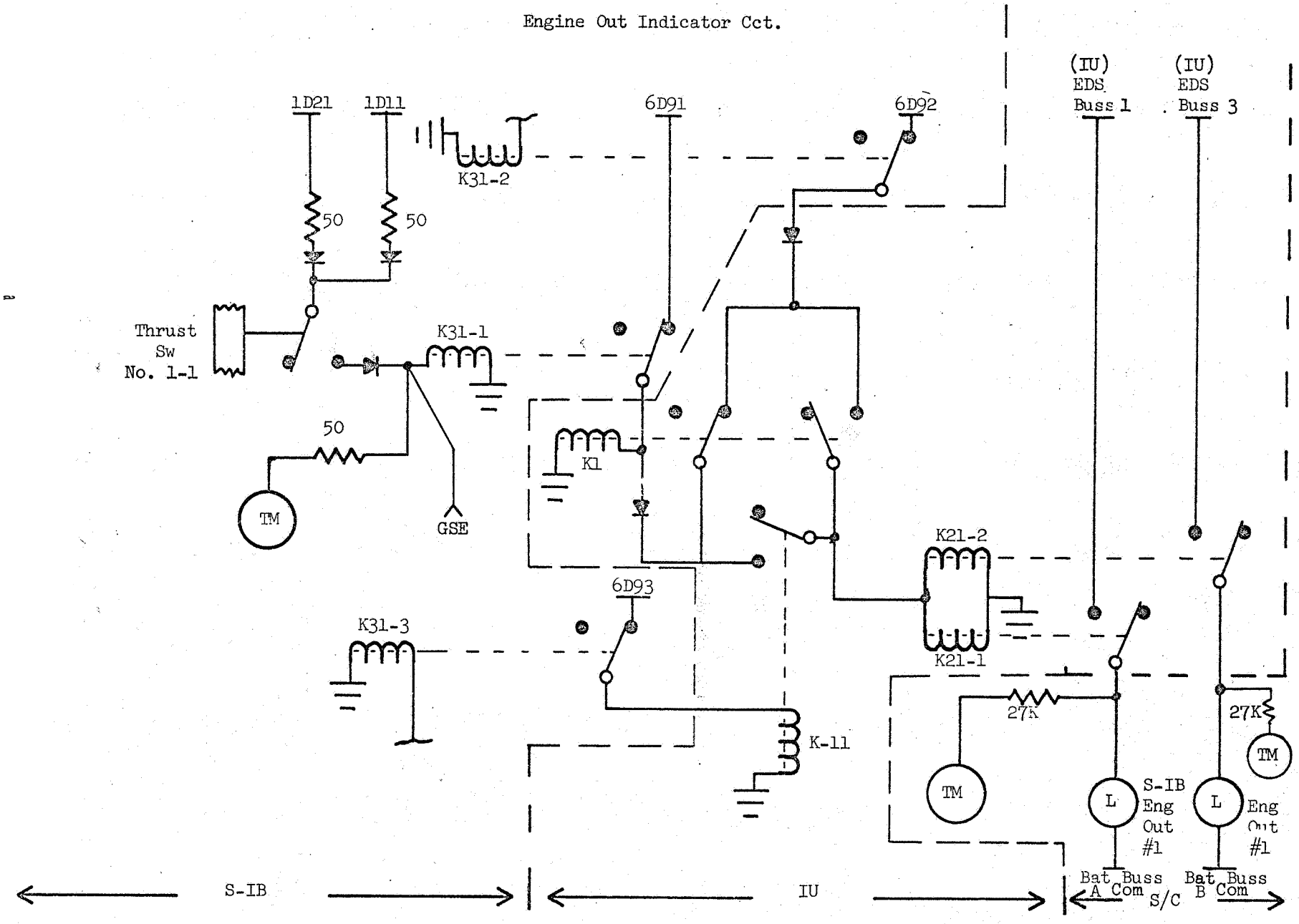
6. EMS MODE Switch

This switch performs the following functions in the positions indicated:

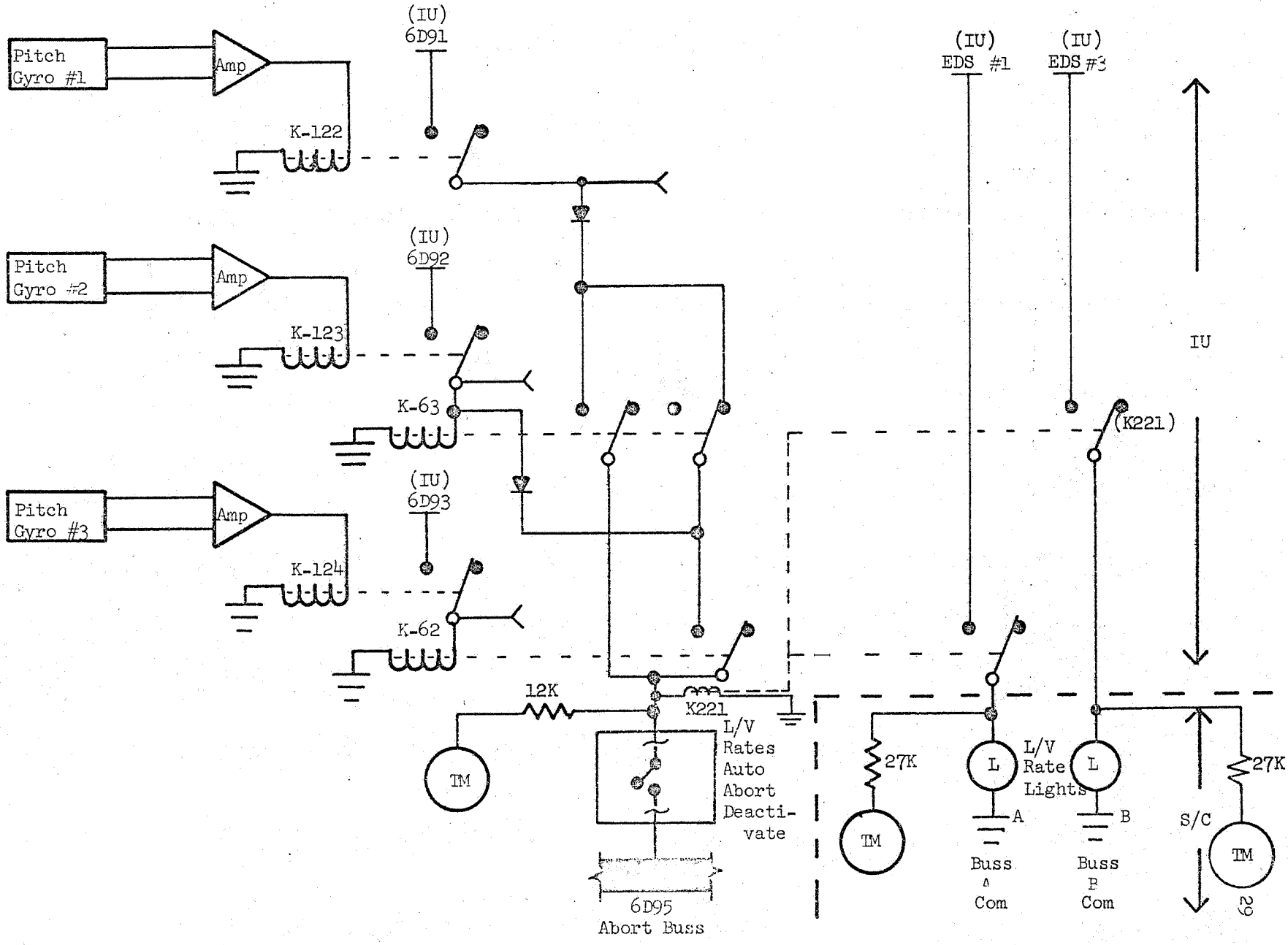
Position	Description
AUTO	1) EMS acts as a backup display for G&N entry 2) Initiates the function on the EMS Mode select switch
STBY	1) Resets circuits following tests 2) Removes power if function switch is off
MAN	1) Position for manual entry and TVC Modes, or auto entry backup display 2) Does not permit negative acceleration spikes into countdown circuits

5. EDS End-to-End Schematics

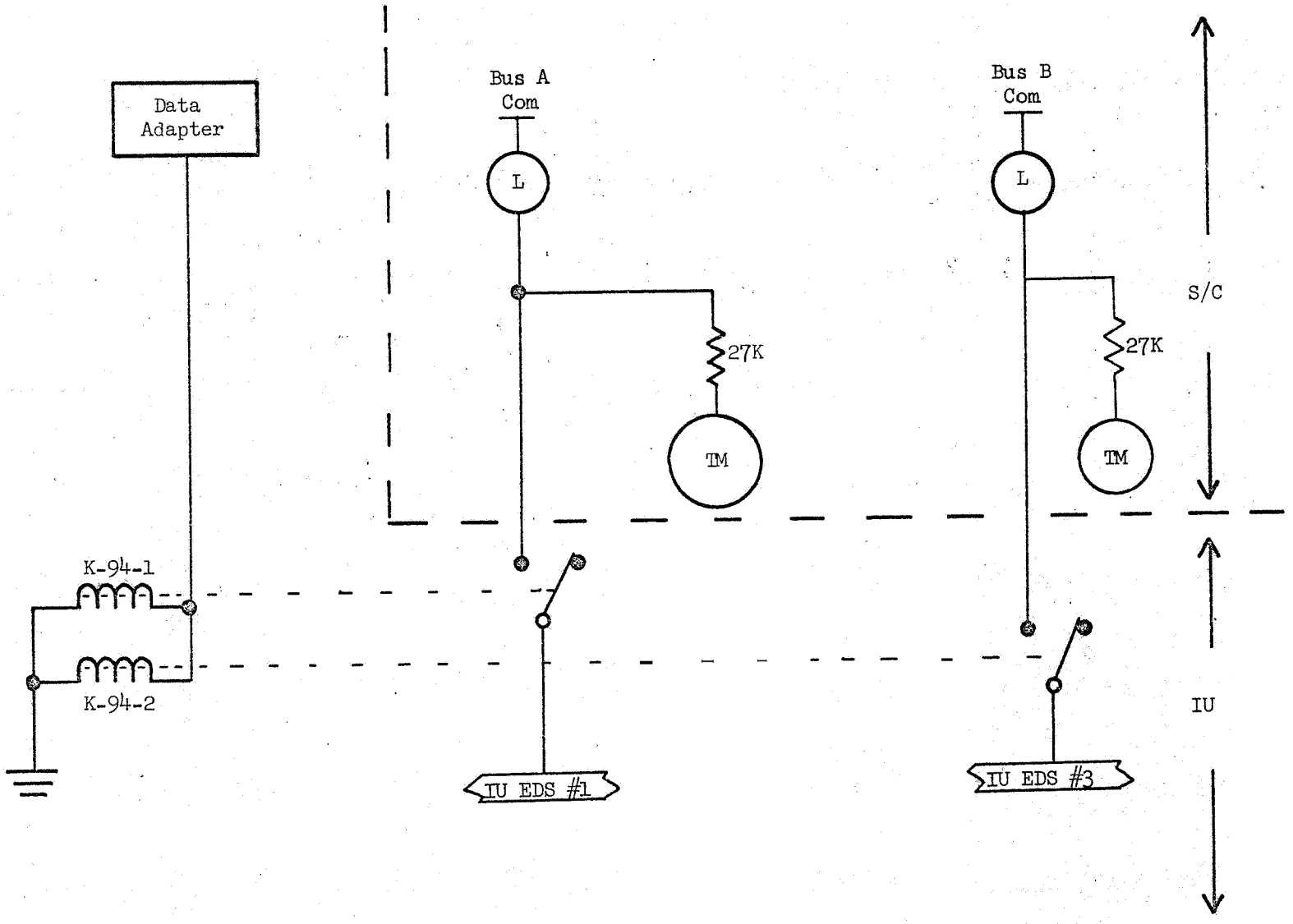
Engine Out Indicator Cct.



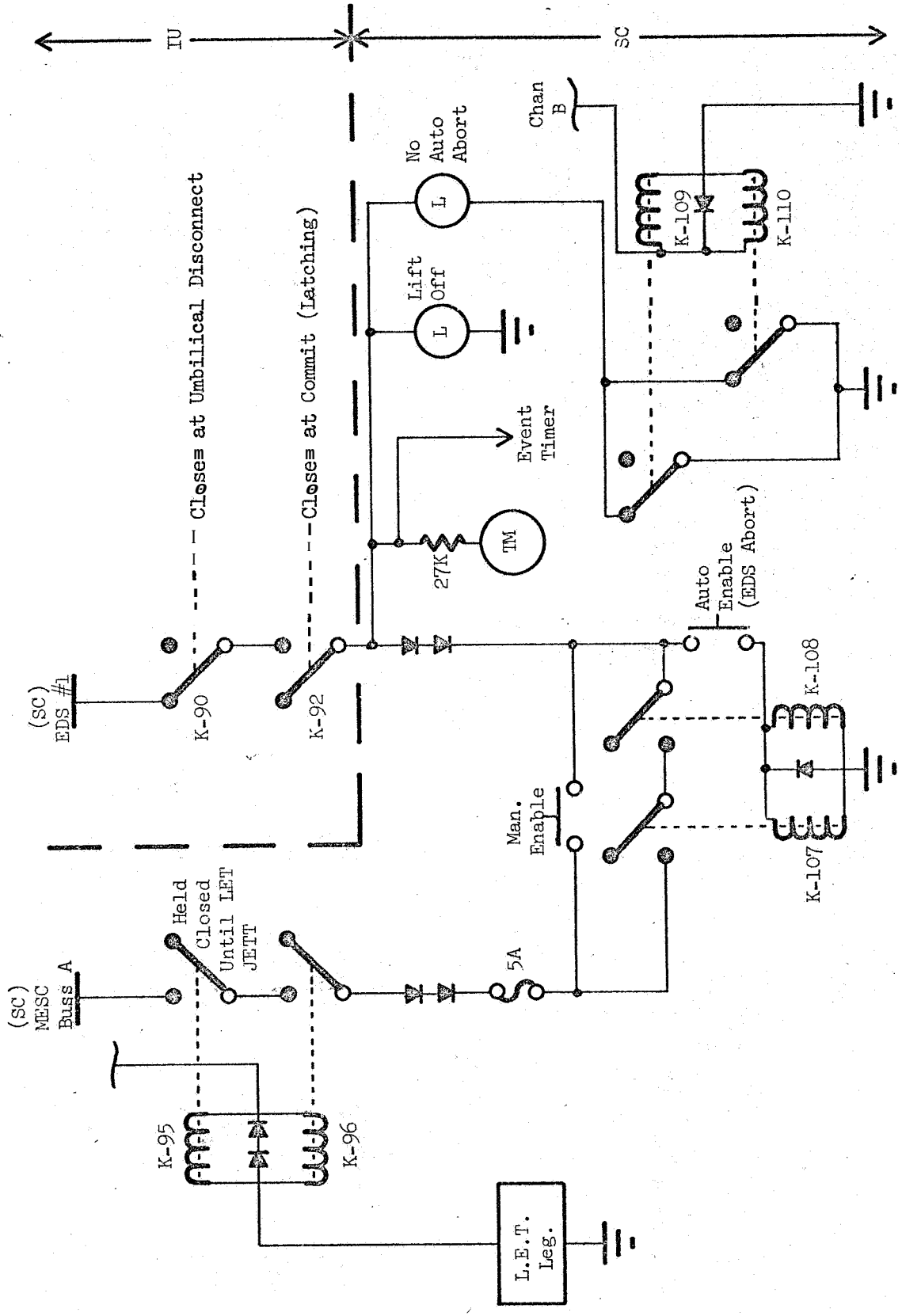
L/V Overrate Indicator Cct.

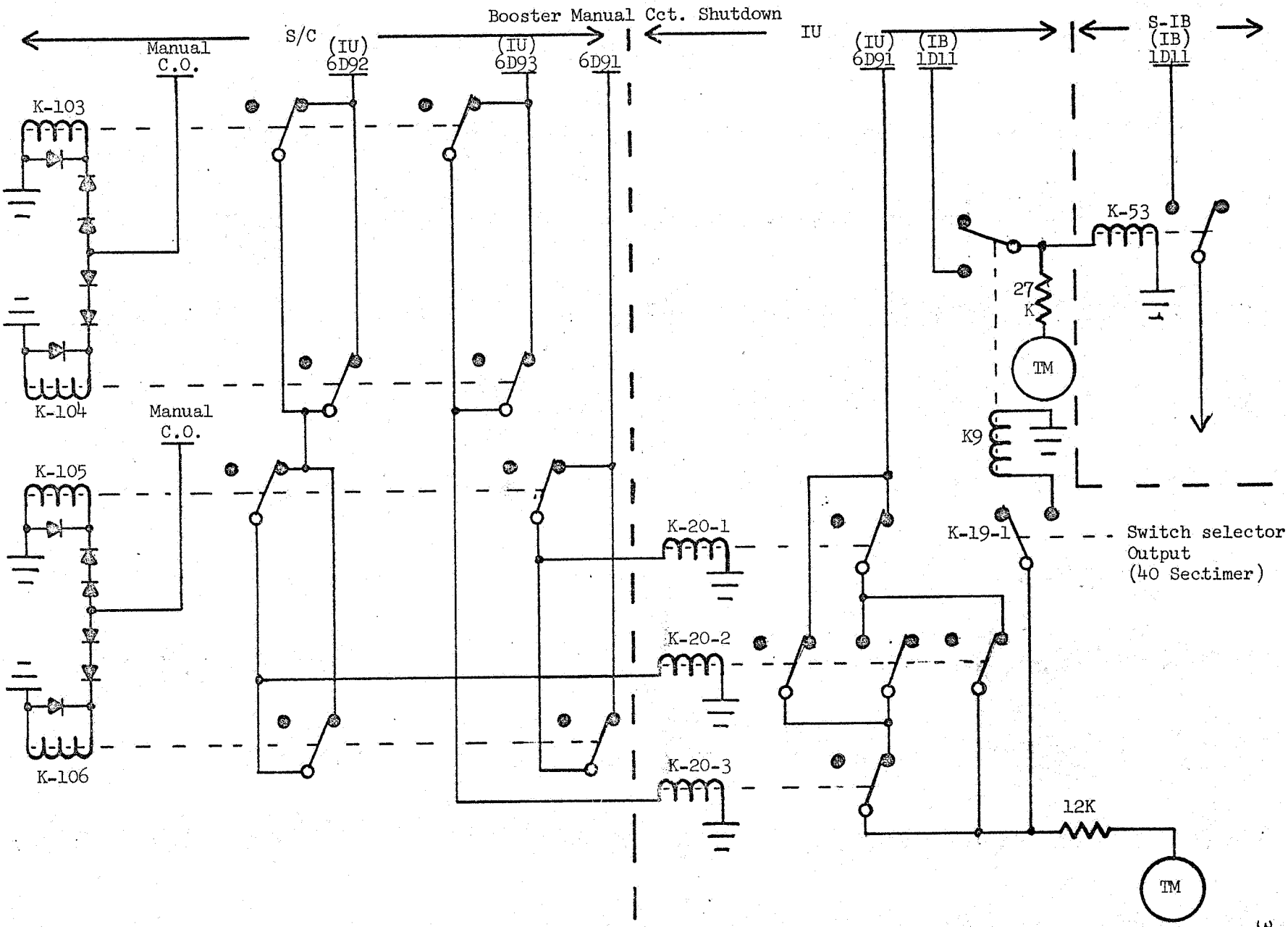


L/V Guidance Fail Indicator Ckt



Auto Abort Enable Cct.




Booster Manual Cct. Shutdown
S/C
IU
S-IB
Manual
C.O.
(IU)
6D92
(IU)
6D93
6D91
(IU)
6D91
(IB)
1D11
(IB)
1D11
K-103
K-104
K-105
K-106
Manual
C.O.
K-53
27
K
TM
K9
K-19-1
Switch selector
Output
(40 Sectimer)
K-20-1
K-20-2
K-20-3
12K
TM

6. EDS Displays Off-Nominal Conditions

	PRIMARY CUE(S)	SUSPECTED CONDITION	SECONDARY CUE(S)	PILOT ACTION
1.	S-IB Engine Light	One Engine Out	Rates Attitude Errors Chi Freeze Angle of Attack	Continue Mission 2 Engine Out - OFF
2	Two Simultaneous S-IB Engine Lights	Two Engines Out (Explosion)	None Required	Abort
3.	Second S-IB Engine Light (After T=15 sec)	Two Engines Out	Acceleration Overrate Attitude Errors LV Rate Light	Abort if LV control is lost Otherwise continue mission-- And advise MCC-H of failures.
4	S-IVB Engine Light (After Staging)	Loss S-IVB Thrust	Acceleration Physiological Overrate Attitude Abort Light	Abort
5	All Engine Lights Stay On at Staging	Failure to Stage	Acceleration Attitude Rates Abort Light Physiological	Abort

Prepared by D. K. Williams
Checked by C. O. Lewis
Approved by E. D. Lyons

	PRIMARY CUE(S)	SUSPECTED CONDITION	SECONDARY CUE(S)	PILOT ACTION
6.	Engine Lights 2 thru 7 Off, Light 1 On (At Staging)	Failure to Start J-2	Acceleration Attitude Rates Abort Light Physiological	Abort
7.	LV Rate Light	LV Overrate (Loss of Control)	Rates Errors Attitude AOA (Limited) Physiological	Abort
8.	LV Guid Light	Loss of LV Guidance Platform	Rates Errors Attitude LV Rate Light AOA (Limited) Physiological	Abort
.	No Roll Rate Needle Displacement	Programmer Failure No Roll Program	Ground Confirmation Roll Error (FDAI)	Continue Mission
.	No Pitch Rate Needle Displacement	Programmer Failure No Pitch Program	Ground Confirmation Pitch Error(FDAI)	Abort on Ground Request
	Large Scale Attitude Ball Displacements (No Overrate)	Guidance and Control Failure	Attitude Errors FDAI Rate Needles AOA (Limited) Ground Confirmation Abort Light LV Guid Light	Abort

Prepared by S. K. Warren
Checked by C. O. Lewis
Approved by R. A. Lewis

	PRIMARY CUE(S)	SUSPECTED CONDITION	SECONDARY CUE(S)	PILOT ACTION
12.	Large Scale Rate Needle Displacement	Guidance and Control Failure	Attitude Errors LV Rate Light Attitude Physiological	bort
13.	Rapid Oscillations	Attitude Ball Failure	Ground Confirmation	Jse Rates and Errors and Redundant Ball
14.	No Auto Abort Red (A[illegible])	Failure to Enable Automatic Abort		Manually Enable Auto Abort at T + 30
15.	No Lift-off Light	Hold Kill	No DET Start No Engine Status Lights ON	None

Prepared by D. K. Warren
Checked by C. O. Lewis
Approved by [illegible]

7. Post Abort Procedures

A. Low Altitude

(Pad to 61 sec)

(Pad to 24000 ft)

NOTE: NUMBERED EVENTS ARE MANUAL. NON-NUMBERED EVENTS ARE AUTOMATIC OR NO ACTION.

DET		BACKUP PROCEDURE
00:00	1. ABORT (MANUAL OR AUTOMATIC)	CM/SM SEP SW (2) - ON
	FOLLOWING EVENTS OCCUR AUTO:	
	BECO (AFTER T + 00:40)	
	EVENT TIMER RESET	Reset and start manually at LES burnout
	CM RCS PRESSURIZE	CM RCS PRESS SW - ON
	RCS TRANS TO CM	RCS TRANS SW - CM
	ENTRY BAT TO MAIN BUS (IF IN AUTO)	
	CM/SM UMB DEADFACE	CM/SM SEP SW (2) - ON
	RCS OX DUMP	
	CM - RCS ISOLATION VALVES CLOSE	CM RCS PRPLNT SW (2) - ON
00:00.1	CM/SM SEPARATION	CM/SM SEP SW (2)
	LES AND PC MOTORS FIRE	LES MOTOR FIRE PB - press (PC motor will not fire)
00:05	CM RCS FUEL DUMP	
00:11	CANARDS DEPLOY	CANARD DEPLOY PB - press
00:14	TOWER JETT	TWR JETT SW (2) - ON
	RCS AUTO SAFED AT TWR JETT	
	ELS ARM AUTO	ELS LOGIC SW - ON
00:14.4	APEX COVER JXTT	APEX COVER JETT PB - press
00:16	DROGUE CHUTES DEPLOY	DROGUE DEPLOY PB - press
00:18	RCS He PURGE	CM RCS He DUMP PB - press

AT 3800* FT INDICATED OR BELOW DEPLOY MAINS MANUALLY.
*ACTUAL MINUMUM ALTITUDE WILL BE SET WITH ALIDADE MARKER ON LAUNCH DAY.

00:28	MAIN CHUTES DEPLOY	MAIN DEPLOY PB - press (If <10K')
	VERIFY MAINS OUT	
	2. DIRECT O_2 - ON (CCW)	
	3. CB FLT & PL BAT BUS A, B AND BAT C (3) - CLOSE	

APOLLO ABORT SUMMARY S/C 101 Rev 2	Flight Crew Support Division Crew Safety & Procedures Branch Date 9-26-67	Prepared by M. L. Hood Checked by J. Penny Approved by D. K. Andrews

4. CB FLT & PL MN A & B *(2)* - **OPEN**
5. FLOOD SW - POST LND
6. FLOOD DIM - 1 OR 2
7. CM PROP JETT LOGIC - OFF
8. CM RCS PRPLNT (2) - OFF
9. MAIN BUS TIE SW (2) - OFF

600' 10. CABIN PRESS RELIEF (2) - BOOST (CLOSE)

11. RELEASE MAINS AFTER TOUCHDOWN
12. POST LANDING CHECKLIST

B. Medium Altitude

Mode IB

(61 sec to 1 min 50 sec)

(24,000 to 100,000 ft)

DET			BACKUP PROCEDURE
00:00	1.	ABORT (MANUAL OR AUTOMATIC) FOLLOWING EVENTS OCCUR AUTO: BECO EVENT TIMER .RESET	CM/SM SEI? SW (2) - ON Reset and start manually at LES burnout
		CM RCS PRESSURIZE	CM RCS PRESS SW - ON
		CM/SM UMB DEADFACE	CM/SM SEP SW (2) - ON
00:00.1		CM/SM SEPARATION LES MOTOR FIRE	CM/SM SEP SW (2) - ON LES MOTOR FIRE PB - press
00:01		CM RCS ENABLED	RCS CMD SW - ON
00:11		CANARDS DEPLOY	CANARD DEPLOY PB - press
00:14		ELS ARM AUTO	ELS LOGIC SW - ON
24K'	2.	TOWER JETT SW (2) - ON RCS DISABLED APEX COVER JETT	RCS CMD SW - OFF APEX COVER JETT PB - press
APEX JETT + 2 SEC		DROGUE CHUTES DEPLOY	DROGUE DEPLOY PB - press
23.5K'	3.	VERIFY CABIN PRESSURE INCREASE	If not increasing by 20K' cabin press release valve - dump
10K'		MAIN CHUTES DEPLOY	MAIN DEPLOY PB - press
00:00	4.	DET - RESET - START	
00:15	5.	DIRFCT O_2 - ON (CCW)	
	6.	CM PROP JETT DUMP SW - DUMP	Use 2 RHC to fire all jetts except + pitch (Direct RCS - ON)
	7.	CM PROP JETT - PURGE (FOR 30 SEC AFTER BURNOFF)	CM RCS He DUMP PB - press
	8.	CB FLT & PL RAT BUS A, B, AND BAT C (3) - CLOSE	
	9.	CB FLT & PL MNA & B (2) - OPEN	
	10.	FLOOD SW - POST LDG	
	11.	FLOOD DIM - 1 OR 2	
	12.	CM PROP JETT LOGIC - OFF	
	13.	DC MAIN BUS TIE SW (2) - OFF	
600'	14.	CABIM PRESS RELIEF (2) - BOOST (CLOSE)	
	15.	RELEASE MAINS AFTER TOUCHDOWN	
	16.	POST LANDING CHECKLIST	

C. High Altitude

Mode IC

(1 min 50 sec to 2 min 46 sec)

(100,000 ft to 300,000 ft)

DET

BACKUP PROCEDURE:

00:00.1

00:01
00:11
00:14

C. WITH RHC ROLL S/C 90°
D. EDUCE RATE WITH YAW RCS
E. ROLL S/C BACK 90° (HEADS DOWN)
F. DIRECT RCS - OFF
G. MAN ATT PITCH - ACCEL CMD
H. ESTABLISH 5°/SEC PITCH *UP* RATE WITH RHC
I. BMAG MODE SW (Y & R) - ATT 1/RATE 2

24K'	3.	TOWER JETT SW (2) - ON	
		RCS DISABLE	RCS CMD SW - OFF
		APEX COVER JETT	APEX COVER JETT PB - press
APEX JETT + 2 SEC		DROGUE CHUTES DEPLOY	DROGUE DEPLOY PB - press
23.5K'	4.	VERIFY CABIN PRESSURE INCREASE	CABIN PRESS RELEASE - dump (If not increasing by 20K')
10K'		MAIN CHUTES DEPLOY	MAIN DEPLOY PB - press
00:00	5.	DET - RESET - START	
	6.	DIRECT O_2 - ON (CCW)	
	7.	CM PROP JETT DUMP SW - DUMP	Use 2 RHC to fire all jetts except pitch (RCS Direct ON)
	8.	CM PROP JETT - PURGE (FOR 30 SEC AFTER BURNOFF)	
	9.	CB FLT & PL BAT BUS A,B, AND BAT C (3) - CLOSE	
	10.	CB FLT & PL MNA & B (2) - OPEN	
	11.	FLOOD SW - POST LDG	
	12.	FLOOD DIM - 1 OR 2	
	13.	CM PROP JETT LOGIC - OFF	
	14.	DC MAIN TIE SW (2) - OFF	
600'	15.	CABIN PRESSURE RELIEF (2) - BOOST (CLOSE)	
	16.	RELEASE MAINS AFTER TOUCHDOWN	
	17.	POST LANDING CHECKLIST	

D. SPS MODE II

(2 min 46 sec to 9 min 30 sec)

DET			BACKUP PROCEDURF:
00:00	1.	ABORT THC - CCW	Warning: Steps (1) thru (15) must be completed within 1 min 40 seconds elapsed time
		FOLLOWING EVENTS OCCUR AUTO:	
		BECO	
		EVENT TIMER RESET	Reset and start manually
		DIRECT ULLAGE START	DIRECT ULLAGE PB - press
00:03		S-IVB/CSM SEP	CSM/LV SEP PB - press
	2.	CMC/SCS - SCS (VERIFY)	THC - CW
00:03.8		SCS STABILIZATION ENABLE	RCS CMD - ON
	3.	LV/SPS IND SW - GPI	
	4.	THC UNLOCK & CENTER	
	5.	EMS MODE - AUTO	
	6.	THC +X TRANS- (MAINTAIN FOR 20 SEC)	
			HIGH RATES:
			1. AV THRUST SW (2) - NORMAL
00:06			2. SPS THRUST OB PB - press or SPS THRUST DIRECT - ON
00:08			3. AV THRUST SW (2) - OFF
			NOTE: Longer thrusting may be required for rate damping.
00:24	7.	TERMINATE +X TRANS (THC - CENTER)	
	8.	START MANEUVER TO ENTRY ATT R=0°, P=126°, Y=0°	
	9.	TIME PERMITTING TRANS RCS TO CM AND CHECK	
	10.	A & C ROLL - OFF	
	11.	CM/SM - SEP (2)	
		FOLLOWING EVENTS OCCUR AUTO:	
		CM/SM DEADFACE	
		CM - RCS PRESS	CM RCS PRESS SW - press
		CM/SM SEP	
		RCS TRANS - CM	RCS TRANS SW - CM
	12.	CAUT & WARN - CM	
	13.	FDAI SCALE - 50/15/50/10	
	14.	NOTE TFF (FOR ENTRY ATT TIME)	
01:40	15.	COMPLETE MANEUVER CM TO FDAI ENTRY ATTITUDE	

	18.	AT .05 G LIGHT .05 G SW - .05 G	
	19.	EMS TO ENTRY	
	20.	EMS ROLL SW - ON (ALIGN)	
50K'	21.	MAINTAIN FULL LIFT	
45K'	22.	ELS LOGIC SW - LOGIC	
24K'		APEX COVER JETT	APEX COVER JETT PB - press
APEX JETT + 2 SEC		DROGUE CHUTES DEPLOY	DROGUE DEPLOY PB - press
23.5K'	23.	VERIFY CABIN PRESSURE INCREASE	CABIN PRESS RELEASE - dump (If not increasing by 20K')
10K'		MAIN CHUTES DEPLOY	MAIN DEPLOY PB - press
00:00	24.	DET - RESET - START	
	25.	DIRECT O_2 - ON (CCW)	
	26.	CM PROP DUMP SW - DUMP	Fire all jetts except pitch (Direct RCS ON)
	27.	CM PROP JETT PURGE - PURGE (FOR 30 SEC AFTER BURNOFF)	
	28.	CB FLT & PL BAT BUS A, B, AND BAT C (3) - CLOSE	
	29.	CB FLT & PL MNA AND B (2) - OPEN	
	30.	FLOOD SW - POST LDG	
	3L.	FLOOD DIM - 1 OR 2	
	32.	CM PROP JETT - LOGIC - OFF	
	33.	DC MAIN TIE SW (2) - OFF	
	34.	CABIN PRESSURE RELIEF (2) - CLOSE	
	35.	RELEASE MAINS AFTER TOUCHDOWN	
	36.	POST LANDING CHECKLIST	

E. SPS Mode III

Retrograde

(9 min 30 sec to insertion)

DET			BACKUP PROCEDURE
00:00	1.	ABORT THC - CCW	Warning: Steps (1) thru (14) must be completed within 2 min 05 sec elapsed time
		FOLLOWING EVENTS OCCUR AUTO:	
		BECO	
		EVENT TIMER RESET	Reset and start manually
		DIRECT ULLAGE START	DIRECT ULLAGE PB - press
00:03		S-IVB/CSM SEP	CSM/LV SEP PB - press
	2.	CMC/SCS - SCS (VERIFY)	THC - CW
00:03.8		SCS STABILIZATION ENABLE	RCS CMD - ON
	3.	LV/SPS IND SW - GPI	
	4.	THC UNLOCK & CENTER	
	5.	EMS MODE - AUTO	
	6.	THC +X TRANS - (MAINTAIN FOR 20 SEC)	
			HIGH RATES:
			1. ΔV THRUST SW (2) - NORMAL
			2. THRUST ON PB - or SPS THRUST DIRECT - ON
			3. ΔV THRUST SW (2) - OFF
			NOTE: Longer thrusting may be required for rate damping
00:24	7.	TERMINATE +X TRANS (THC - CENTER)	
	8.	MANEUVER CSM TO RETRO ATTITUDE (FDAI APPROX R=180°, P=200°, Y=0°) RETICLE ON HORIZON, BEF, HEADS UP	
	9.	OBTAIN RETRO UPDATE	
	10.	BMAG MODE SW (3) - ATT 1/RATE 2	
	11.	CHECK MTVC AND GIMBAL ANGLES	
	12.	ΔV THRUST SWITCH (2) - NORMAL	
01:50	13.	START ULLAGE (THC)	DIRECT ULLAGE PB - press
02:05	14.	THRUST ON PB - PRESS	ΔV THRUST - DIRECT
02:06	15.	STOP ULLAGE (THC - NEUTRAL)	DIRECT ULLAGE PB - release
	16.	THRUST TERMINATE AT ΔV REMAINING = DESIRED VALUE ΔV THRUST SW (2) - OFF	Burn AR = 0 on DSKY

	17.	TIME PERMITTING TRANS RCS TO CM AND CHECK RCS	
	18.	A/C ROLL SW - OFF	
	19.	CM/SM SEP (2) - ON	
		FOLLOWING EVENTS OCCUR AUTO:	
		CM/SM DEADFACE	
		CM RCS PRESS	CM RCS PRESS SW - ON
		CM/SM SEP	
		RCS CONTROL TRANS TO CM	RCS TRANS - CM
	20.	CAUT & WARN - CM	
	21.	FDAI SCALE - 50/15/50/10	
	22.	MANEUVER CM TO FDAI ENTRY ATTITUDE	
		R=297.5°, P=120°, Y=17°	
		(BEF, HEADS DOWN, HALF LIFT VECTOR SOUTH)	
		OBTAIN ROLL, PITCH, AND YAW UPDATE	
	23.	SET UP FOR SINGLE RING RCS (A)	
	24.	BMAG MODE SW (2) RATE 2	
	25.	AT .05 G LIGHT, .05 G SW - ON	
	26.	EMS FUNCTION - ENTRY	
	27.	EMS ROLL - ON (ALIGN)	
50K'	28.	MAINTAIN HALF LIFT	
45K'	29.	ELS LOGIC SWITCH - LOGIC	
24K'		APEX COVER JETT	APEX COVER JETT PB - press
APEX JETT + 2 SEC		DROGUE CHUTES DEPLOY	DROGUE DEPLOY PB - press
23.5K'	30.	VERIFY CABIN PRESSURE INCREASE	CABIN PRESS RELEASE - dump (If not increasing by 20K')
10K'		MAIN CHUTES DEPLOY	MAIN DEPLOY PB - press
00:00	31.	DET - RESET - START	
00:15	32.	DIRECT O_2 - ON (CCW)	
	33.	CM PROP JETT DUMP SW - DUMP	Rotate RHC to fire all jetts except pitch (RCS DIRECT - ON)
	34.	CM PROP JETT PURGE - PURGE (FOR 30 SEC AFTER BURNOFF)	CM RCS He DUMP PB - press
	35.	CB FLT & PL BAT BUS A, B, AND BAT C (3) - CLOSE	
	36.	CB FLT & PL MNA AND B (2) - OPEN	
	37.	FLOOD SW - POST LDG	
	38.	FLOOD DIM - 1 OR 2	
	39.	CM PROP JETT - LOGIC - OFF	
	40.	DC MAIN TIE SW (2) - OFF	
	41.	CABIN PRESSURE RELIEF (2) - CLOSE	
	42.	RELEASE MAINS AFTER TOUCHDOWN	
	43.	POST LANDING CHECKLIST	

F. SPS Mode IV

Posigrade

(9 min 21 sec to insertion)

DET			BACKUP PROCEDURE
00:00	1.	ABORT THC - CCW	Warning: Steps (1) thru (14) must be completed within 2 min 05 sec elapsed time
		FOLLOWING EVENTS OCCUR AUTO:	
		BECO	
		EVENT TIMER RESET	Reset and start manually
		DIRECT ULLAGE START	DIRECT ULLAGE PB - press
00:03		S-IVB/CSM SEP	
	2.	CMC/SCS - SCS	THC - CW
00:03.8		SCS STABILIZATION ENABLE	
	3.	LV/SPS IND SW - GPI	
	4.	UNLOCK THC & CENTER	
	5.	EMS MODE - AUTO	
	6.	START ULLAGE (+X TRANS - MAINTAIN FOR 20 SEC)	Direct ullage
			HIGH RATES:
			1. ΔV THRUST SW (2) - NORMAL
00:06			2. SPS THRUST PB - or SPS THRUST DIRECT - ON
00:08			3. ΔV THRUST SW (2) - OFF
			NOTE: Longer thrusting may be required for rate damping
00:24	7.	TERMINATE +X TRANS (THC - CENTER)	
	8.	MANEUVER CSM TO INSERTION ATTITUDE (FDAI APPROX R=180°, P=353°, Y=0°) RETICLE ON HORIZON, SEF, HEADS DOWN	
	9.	OBTAIN INSERTION UPDATE	
	10.	BMAG MODE SW (3) - ATT 1/RATE 2	
	11.	CHECK MTVC & GIMBAL ANGLES	
	12.	AV THRUST SWITCH (2) - NORMAL	
01:50	13.	START ULLAGE (THC)	DIRECT ULLAGE PB - press
02:05	14.	SPS THRUST PB - PRESS	SPS THRUST --Direct
02:06	15.	STOP ULLAGE (THC - CENTER)	DIRECT ULLAGE PB - Release
	16.	ΔV THRUST SW (2) - OFF AT AV = DESIRED VALUE	Burn hp = 75 nm on DSKY
	17.	INSERTION CHECKLIST	

G. Fixed ΔV Mode

Retrograde

(9 min 51 sec to 22 min 39 sec)

DET			BACKUP PROCEDURE
		ASSUME INSERTION CHECKLIST NOT PERFORMED	
00:00	1.	ABORT THC - CCW FOLLOWING EVENTS OCCUR AUTO: BECO (IF ABORT OCCURS PRIOR TO ECO) EVENT TIMER RESET	Reset and start manually
		DIRECT ULLAGE START	DIRECT ULLAGE PB - press
00:03		S-IVB/CSM SEP	CSM/LV SEP PB - press
	2.	CMC/SCS - SCS (VERIFY)	THC - CW
00:03.8		SCS STABILIZATION	RCS CSM - ON
	3.	THC UNLOCK & CENTER	
	4.	START ULLAGE (+X TRANS - MAINTAIN FOR 20 SEC)	
00:24	5.	STOP ULLAGE (THC - CENTER)	
	6.	MANEUVER CSM TO RETRO ATTITUDE (FDAI APPROX R=180°, P=148°, Y=0°) RETICLE ON HORIZON, BEF, HEADS UP	
	7.	OBTAIN RETRO ATTITUDE UPDATE AND IGNITION TIME	
	8.	BMAG MODE SW (3) - ATT 1/RATE 2	
	9.	ENTER SPLASHDOWN COORDINATES IN DSKY FROM GROUND INFORMATION	
	10.	LV/SPS IND SW - GPI	
	11.	CHECK MTVC AND GIMBAL ANGLES	
	12.	AV THRUST SW (2) - NORMAL	
-00:15*	13.	START ULLAGE (THC +X TRANS)	DIRECT ULLAGE PB - press
-00:00*	14.	THRUST ON PB - PRESS	SPS THRUST DIRECT - ON
+00:01	15.	STOP ULLAGE (THC - NEUTRAL)	
	16.	BURN FIXED AV OF 400 FPS AV THRUST SW (2) - OFF	

PROCEED TO STEP 17 OF SPS MODE III PROCEDURES WITH THE EXCEPTION: ITEM 22 FOR MODE I BRAVO WILL READ:

22. MANEUVER CM TO FDAI ENTRY ATTITUDE
R=298°, P=45°, Y=17°
(BEF, HEADS DOWN, LIFT VECTOR SOUTH)
OBTAIN ROLL, PITCH, AND YAW UPDATE

* USE MISSION TIMER

8. LV/SC Separation Failure

(RCS Deorbit)

DET		BACKUP PROCEDURF:
	ASSUME: PRERETRO CHECKLIST COMPLETE. IMU OR GDC ALIGNED AND OPERATIVE,	
	1. SET CONTROLS TO G&N BASIC EXCEPT: A. SC CONT - SCS B. BMAG MODE (3) - ATT 1/RATE 2 C. MANUAL ATTITUDE (3) - RATE CMD D. ATT SET - IMU	ATT SET - GDC
-lo:oo	2. SET ATT SET DIALS R= P= Y= OBTAIN TIME TO BURN FROM GROUND UPDATE	
	3. MANEUVER TO RETRO ATTITUDE (FDAI ERRORS NULLED)	
	4. LV GUIDANCE - I.U. (S-NB ATT CONT WILL HOLD VEHICLE ATTITUDE WITH RESPECT TO LOCAL VERTICAL)	
	5. SCS CHANNELS (4) - OFF	If S-IVB ATT HOLD fails: 1. LV GUID - CMC 2. **RCS** CMD - ON 3. SCS channels (3) - ON (Control vehicle manually using ORDEAL driven FDAI.)
- 5:00	6. EMS FUNCTION - **AV** SET	
	7. SET **AV** COUNTER FROM GROUND UPDATE (UNDER IDEAL CONDITIONS 185 FT/SEC IS AVAILABLE IF SM RCS FUEL IS BURNED TO DEPLETION)	
	a. EMS FUNCTION - **AV**	
	9. MAIN BUS TIE (BOTH) - ON	
	10. CM PROP JETT LOGIC - ON	
-00:30	11. EMS MODE - AUTO	
00:00	12. THC - CCW & HOLD	THC +X trans (Control SC attitude manually)
	13. THC - CENTER **AV** COUNTER = 0	Terminate +X trans
	14. CM RCS - ON	
	15. CM RCS PRESS - ON	
	16. RCS TRANS - CM	
	17. SCS CHANNELS B & D ROLL, PITCH, AND YAW - ON	
	18. TEST FIRE CM RCS	

19. ARM MESC & PYRO CCTS
20. CM/SM SEP (2) - ON
    FOLLOWING EVENTS OCCUR AUTO:
    CM/SM DEADFACE
    CM RCS PRESS
    RCS TRANS TO CM
    CM/SM SEP
21. C&W - CM
22. PROCEED TO CM RCS DEORBIT PROCEDURE
    (IF EXTRA. AV NEEDED, BURN h_p TO 45 N.M.)
23. PROCEED TO NORMAL ENTRY PROCEDURES

9. On Orbit Abort Procedure

(Abort from S-IVB)

ASSUME: SC SWITCH POSITIONS ARE IN THE BOOST CONFIGURATION. VEHICLE STABILITY IS CONTROLLED BY S-IVB ATTITUDE CONTROL SYSTEM (IU).

		BACKUP PROCEDURF,
1.	ADAPT SEP PB - PUSH	THC - CCW
2.	THC UNLOCK & +X START	DIRECT ULLAGE PB - Push
3.	RCS CMD - ON	
4.	S-IVB/GPI SW - GPI	
+ 2 sec 5.	AV THRUST SW (2) - NORMAL	
6.	SPS THRUST ON PB - PUSH	SPS THRUST - DIRECT ON
7.	STOP +X	Release DIRECT ULLAGE PB
Gnd Supplied 8.	AV THRUST SW (2) - OFF	

10. CM RCS (Pitch) Deorbit Procedures

NOTE: PRERETRO CHECKLIST COMPLETE

		BACKUP PROCEDURF,
1.	SC CONT - SCS	THC - CW
2.	DIRECT RCS - ON	
3.	MAN ATT SWITCHES (3) - RATE CMD	
4.	FDAI SOURCE - IMU	FDAI Source - GDC
5.	LIMIT CYCLE - OFF	
6.	CM/SM SEP (2) - ON FOLLOWING EVENTS OCCUR: CM/ SM DEADFACE CM RCS PRESS CM/SM SEP RCS CONT TRANS TO CM	CM RCS PRESS - ON RCS TRANS - CM
7.	MANEUVER TO RETRO ATTITUDE* R=0° P= -70.5° Y=0°	* Referenced to SC velocity vector
8.	CMP FIRES (-) PITCH ENGINES CONTINUOUSLY WITH ROT CONT #2 WHILE CDR FIRES (+) PITCH ENGINES WITH ROT CGNT #1 (PULSES). ALL ATTITUDE CORRECTIONS ARE MADE BY THE CDR.	
9.	TERMINATE RETRO BURN ON DSKY OR GROUND INFO.	
10.	NORMAL ENTRY PROCEDURES	

11. CM RCS (Yaw) Deorbit Procedures

NOTE: PRERETRO CHECKLIST COMPUTE

1. SC CONT - SCS — THC - CW
2. DIRECT RCS - ON
3. MAN ATT SWITCHES (3) - RATE CMD
4. FDAI SOURCE - IMU — FDAI SOURCE - GDC
5. LIMIT CYCLE - OFF
6. CM/SM SEP (2) SEP
   FOLLOWING EVENTS OCCUR AUTO:
   CM/SM DEADFACE
   CM RCS PRESS — CM RC$ PRESS SW - ON
   CM/SM SEP
7. MANEUVER TO RETRO ATTITUDE* — * Referenced to SC velocity vector
   R=90° P=0° Y=0°
8. CDR ROCKS CM BACK & FORTH WITH YAW ENGINES. FIRE ENGINES FROM 30° to 60° ON EACH SIDE OF CENTER POINT, WHILE MONITORING BODY-YAW IN PITCH PLANE ON THE FDAI
9. TERMINATE RETRO BURN ON TIME INFORMATION OR DSKY INFO
10. NORMAL ENTRY PROCEDURES

12. Emergency Water Egress

(S/C Inundated)

1. OPEN RAPID REPRESSURIZATION VALVE
   ENTRY VALVE - FILL
2. RELEASE LAP, SHOULDER, AND FOOT RESTRAINTS
3. LOWER INBOARD ARM RESTS
4. DISCONNECT ELECTRICAL AND O_2 UMBILICALS
5. OPEN SIDE HATCH AND EGRESS
6. **INFLATE** LIFE VESTS
7. **REMOVE HELMETS** WHEN ON SURFACE

13. Stuck SM RCS Thrusters

1. VERIFY DIRECT RCS SWITCH - OFF
2. SCS CHANNEL SWITCHES - OFF

Note: If power turnoff is pot effective turn propellant; isolation switches (8) OFF and proceed to Step 8.

3. DIRECT RCS SWITCE - ON
4. STOP CSM ROTATION WITH DIRECT RCS CONTROL
5. ALL RCS ENGINE CIRCUIT BREAKERS - OFF
6. ALL SCS CHANNEL SWITCHES - ON
7. REPOSITION RCS CIRCUIT BREAKERS ONE AT A TIME TO ISOLATE THE FAILED ENGINE
8. IF ELECTRICAL ISOLATION IS NOT EFFECTIVE (STEP 2) TURN PRIMARY AND SECONDARY PROPELLANT ISOLATION SWITCHES ON ONE AT A TIME TO ISOLATE THE FAILED RCS QUAD
9. ADVISE GROUND OF ACTION TAKEN

14. Stuck CM Thrusters

1. VERIFY DIRECT RCS SWITCH - OFF
2. ALL SCS CHANNEL SWITCHES (4) - OFF

Note: If power turnoff is not effective turn propellant shutoff switches OFF and proceed to Step 8.

3. DIRECT RCS SWITCH - ON
4. STABILIZE CM WITH DIRECT RCS CONTROL
5. ALL RCS ENGINE CIRCUIT BFEAKERS - OFF
6. ALL SCS CHANNEL SWITCHES (4) - ON
7. REPOSITION RCS CIRCUIT BREAKERS ONE AT A TIME TO ISOLATE THE FAILFD ENGINE
8. IF ELECTRICAL ISOLATION IS NOT EFFECTIVE (STEP 2) TURN A AND B PROPELLANT SHUTOFF VALVES ON ONE AT A TIME TO ISOLATE THE FAILFD SYSTEM
9. ADVISE GROUND OF ACTION TAKEN

15. TWR JETT Failure Procedure

A. TWR CUT/NO JXTT MOTOR FIRE

1. Fire Main LES Motor manually - LES Motor Fire PB - Press

   (a) If tower jettisons - continue mission
   (b) No response - shut down S-IVB THC - CCW (SPS Abort)

      (1) Translate 10 seconds for safe distance from S-IVB
      (2) THC - Center and Unlock
      (3) Perform -X Translation with THC "back away from LET"
      (4) Perform SPS Abort procedures (Mode 11)

B. NO RESPONSE TO TWR JXTT SWITCHES

1. Insure MESC & PYRO Arm Switches - ON (4)

2. Insure EDS Power Switch - ON (1)

3. Insure EDS CB's - ON (3)

4. Insure MESC Arm & Logic CB's - ON (4)

5. Attempt TWR JETT

   (a) TWR JETT Successful - Continue mission
   (b) Not Successful - Perform Manual LES Abort - THC - CCW (Mode IC) ELS will apply power to Jett Twr at 24K'

16. Fire/Smoke in Spacecraft - Suited

1. DIRECT O_2 - OPEN
2. CABIN FANS - OFF
3. SUIT COMPRESSORS - OFF
4. SUIT CIRCUIT RETURN AIR VALVE - CLOSED
5. CABIN REPRESS - CLOSED
6. EMERGENCY CABIN PRESSURE - OFF
7. CABIN PRESSURE REGULATOR - OFF
8. CABIN PRESSURE RELIEF - DUMP
9. HATCH VENT VALVE - OPEN
10. ISOLATE FIRE SOURCE AND REMOVE ELECTRICAL POWER FROM THE AFFECTED SUBSYSTEM
11. USE PORTABLE FIRE EXTINGUISHER AS REQUIRED
12. NOTIFY MCC-H

17. Fire/Smoke in Spacecraft - Unsuited

1. DONN EMERGENCY MASKS
2. EMERGENCY OXYGEN - ON (UP)
3. CABIN FAN(S) - OFF
4. USE PORTABLE FIRE EXTINGUISHERS AS REQUIRED
5. DIRECT O_2 - OFF
6. SUIT CIRCUIT RETURN AIR VALVE - CLOSED
7. SUIT COMPRESSORS - OFF
8. ISOLATE FIRE: SOURCE AND REMOVE ELECTRICAL POWER FROM AFFECTED SUBSYSTEM(S)
9. NOTIFY MCC-H
10. DETERMINE VALIDITY OF SUIT LOOP AND PGA

CAUTION

WITH INCAPACITATED CREWMEN OR PGA/ECS DAMAGED BY FIRE EXECUTE EMERGENCY ENTRY PROCEDURE WITHOUT DEPRESSURIZATION.

11. DIRECT O_2 - ON
12. DONN PGA
13. CABIN REPRESS - CLOSED
14. EMERGENCY CABIN PRESSURE - OFF
15. CABIN PRESSURE REGULATOR - OFF

WHEN ALL CREWMEN SUITED AND SUIT LOOP PURGED:

16. EMERGENCY OXYGEN - OFF (DOWN)
17. CABIN PRESSURE RELIEF - DUMP
18. HATCH VENT VALVE - OPEN
19. NOTIFY MCC-H

18. Emergency Repressurization - Rapid

1. REMOVE PIN FROM RAPID REPRESS TOGGLE
2. W I D REPRESS TOGGLE - OPEN *(UP)*
3. PLSS VALVE - ON
4. SURGE TANK VALVE - ON
5. MONITOR CABIN (INCREASE) AND SURGE TANK (DECREASE) PRESSURE
   NOTE: SITFICIENT O_2 IS AVAILABLE FROM SURGE TANK AND EMERGENCY O_2 TANKS TO PRESSURIZE THE CM FROM ZERO TO 3 PSI IN 55-60 SECONDS
6. AT 150 PSIG (SURGE TANK)
   RAPID REPRESS TOGGLE - CLOSED
   SURGE TANK VALVE - CLOSED .
   PLSS VALVE - OFF
   SM SUPPLY VALVE - FILL
7. NOTIFY MCC-H
8. MODULATE RAPID REPRESS VALVE, PLSS VALVE, SM SUPPLY VALVE AND RAPID REPRESS TOGGLE AS REQUIRED TO BRING CABIN PRESSURE TO ACCEPTABLE LEVEL (3.5 to 6.0 PSI)
   NOTE: MAINTAIN SURGE TANK PRESSURE ABOVE 150 PSIG

19. Emergency Water Egress

(Spacecraft Taking on Water)

1. OPEN RAPID FEPRESSURIZATION VALVE.
2. ENTRY VALVE - FILL
3. START FLOAT BAG FILL
4. REMOVE HELMETS AND INSTALL NECK DAMS
5. RELEASE LAP, SHOULDER, AND FOOT RESTRAINTS
6. DISCONNECT O_2 UMBILICALS
7. IF TIME PERMITS, CONTACT RECOVERY FORCES.
   DETERMINE IF IMMEDIATE EGRESS REQUIRED.
   IF SO, PROCEED.
8. DISCONNECT ELECTRICAL UMBILICALS
9. FEMOVE SURVIVAL KIT (RUCKSAK A & B) FROM STOWAGE.
10. VERIFY LIFE VESTS ON
11. LOWER INBOARD ARM RESTS
12. OPEN SIDE HATCH *AND* EGRESS WITH SURVIVAL GEAR
13. INFLATE LIFE VESTS
14. DEPLOY LIFE RAFT AND OTHER SURVIVAL GEAR IF FEQUIRED.

20. Manual Attitude Control of S-IVB
(On Orbit)

Determine need for manual control of vehicle attitude.

1. Callup R03 and sit in vehicle configuration as follows:
   a. Key V48E (Record BCDE)
   b. Key V21E
      Load 3BCDE
   c. Key Proceed (STDBY) three times

2. Enable RHC for vehicle control as follows:
   Key V46E

3. GUID SW - CMC

4. Exercise manual control capability in all axes. (Minimum of 5°)

5. Terminate manual control as follows:
   a. Key 48E
   b. Key V21E
   c. Key V34E
   d. Key V56E

6. GUID SW - I.U.

NOTE: WHEN CONTROL OF THE VEHICLE IS RETURNED TO THE LV (I.U.) THE NORMAL ATTITUDE TIMELINE WOULD BE PICKED UP IN REAL TIME AS IF IT HAD NEVER BEEN INTERRUPTED.

21. Hold Kills

The four rules covering cutoffs between S-IB ignition and commit (lift-off command) are:

a. Ignition shall be regarded as the beginning of the mission. Therefore, cutoffs during the period discussed here, must be limited to those directly affecting crew safety.

b. All hardline cutoffs must be inhibited a finite time prior to commit.

c. Loss of the EDS automatic abort capability is not a reason for cutoff.

d. Cutoffs will not be initiated for the status of devices (i.e., relays, switches, and valves) which are positioned prior to ignition.

These rules have reduced the original number of cutoffs to nine. A brief description of each follows:

a. S-IB premature commit - The actual parameter monitored is the S-IB cutoff bus (+1D14). The bus is scheduled to be energized with the commit signal. The bus is designed to be active only during flight. If it is powered prior to the engines attaining full thrust, it will supply power to the conax valves and shut down the engines, A simultaneous ground cutoff will occur also.

b. S-IB networks failure - This cutoff occurs if the S-IB vehicle primary voltage is not within tolerance.

c. S-IB thrust failure - Cutoff will occur if the all engines running signal is not present at T - 500 ms. A thrust failure cutoff is inhibited after this time to avoid any possibility of simultaneous commit and cutoff. Under normal conditions all engines should be up to full thrust by T - 1.5 seconds, If a cutoff does occur for an engine failure it will be at T - 0.5 seconds.

d. S-IB fire detection - Located above the flame deflection insulation panels in the boattail area are four sets of thermocouples, each set covering all eight engines. If a fire is present in the boattail the sensors will detect a rate of temperature rise, If it exceeds a predetermined rate, an instantaneous cutoff will occur.

e. S-IVB stage failure - Three parameters are monitoredto insure that the S-IVB primary electrical power systems are operating within prescribed limits. Loss of any of the three causes instant cutoff.

f. IU stage failure - Four parameters showing the status of the guidance and electrical power systems are monitored. Out-of-tolerance conditions of any circuit causes instant cutoff.

g. IU EDS failure - If an abort signal is generated on any one of three spacecraft abort circuits or if the abort bus (6D95) is inadvertently energized prior to T - 0 an instantaneous cutoff will occur.

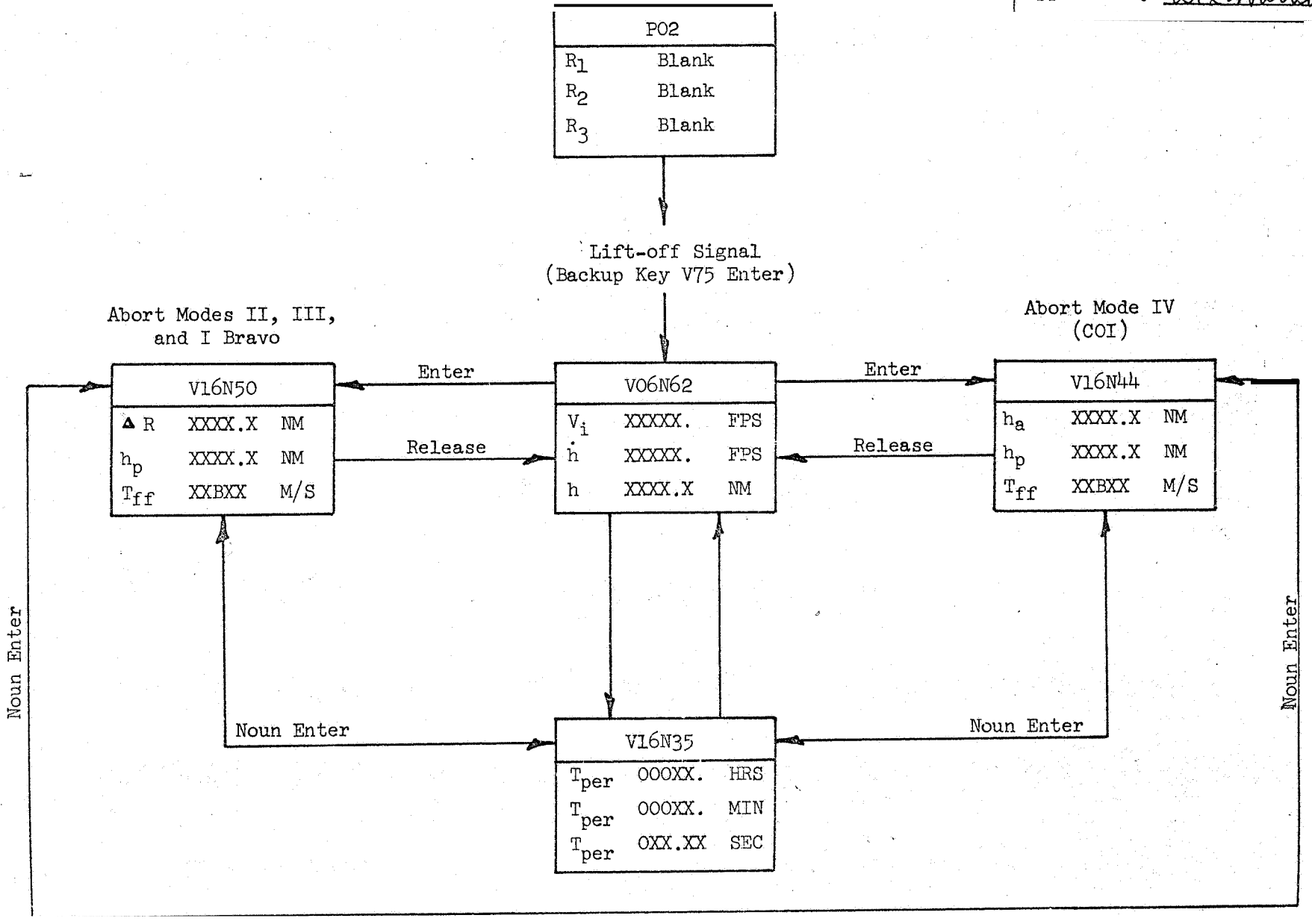
h. S-IB launch failure - If lift-off does not occur within eight seconds from ignition, cutoff will occur automatically. Power is supplied from the blockhouse for the cutoff.

i. S-IB emergency cutoff - A manual switch is located on the S-IB firing panel to cover emergency conditions [exception to rule (c)].

22 DSKY Logic Flow for Boost and Post Abort

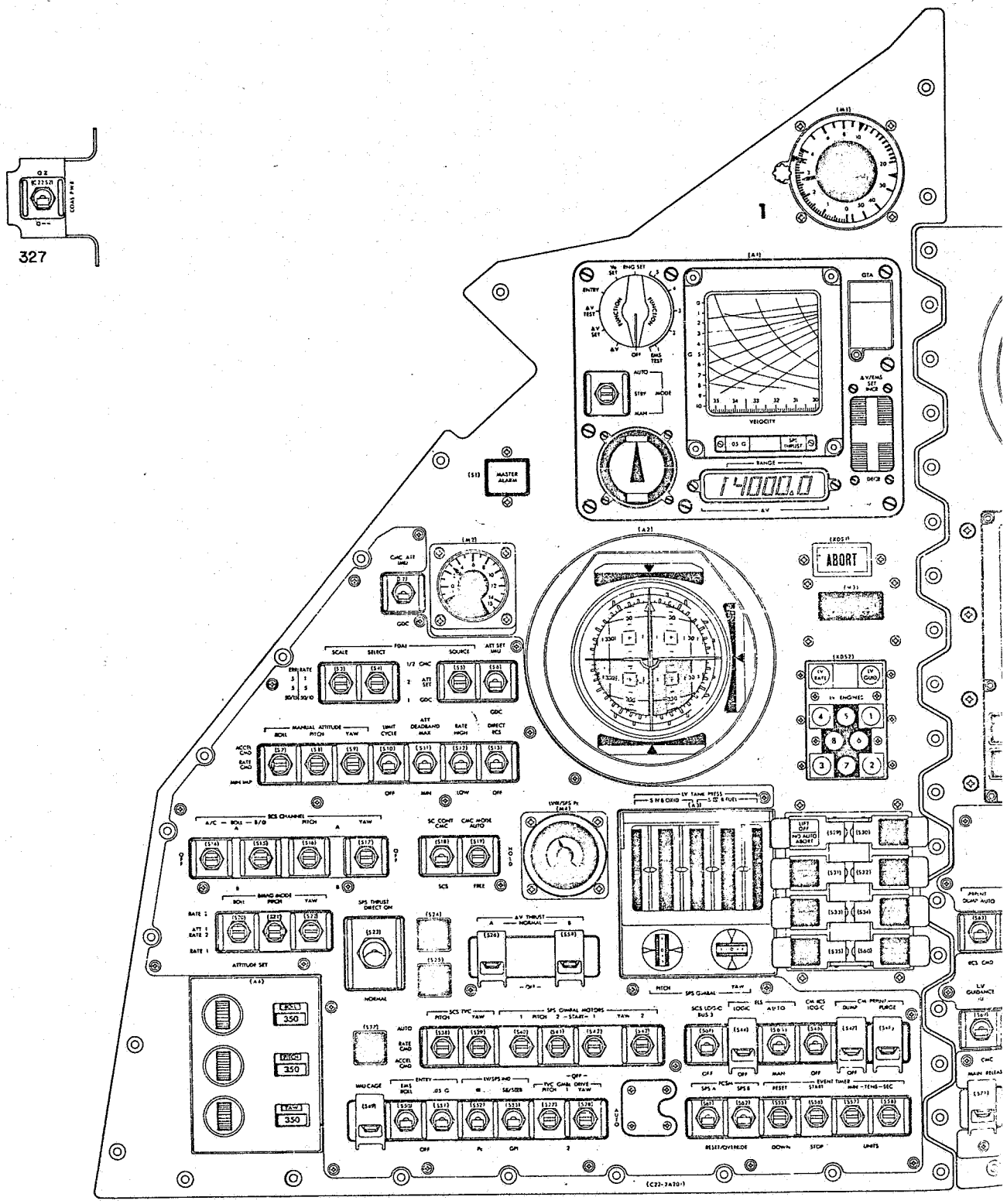
(Program 11 Displays)

Prepared by J. Rippy
Checked by M. Hoot
Approved by D. K. Harrison



23. Trajectory Data

Present planning for the Saturn 205/101 mission launch trajectory designates insertion with a 120 by 150 nautical mile orbit. Detailed performance data for nominal and abort parameter studies are not available for publication until officially released.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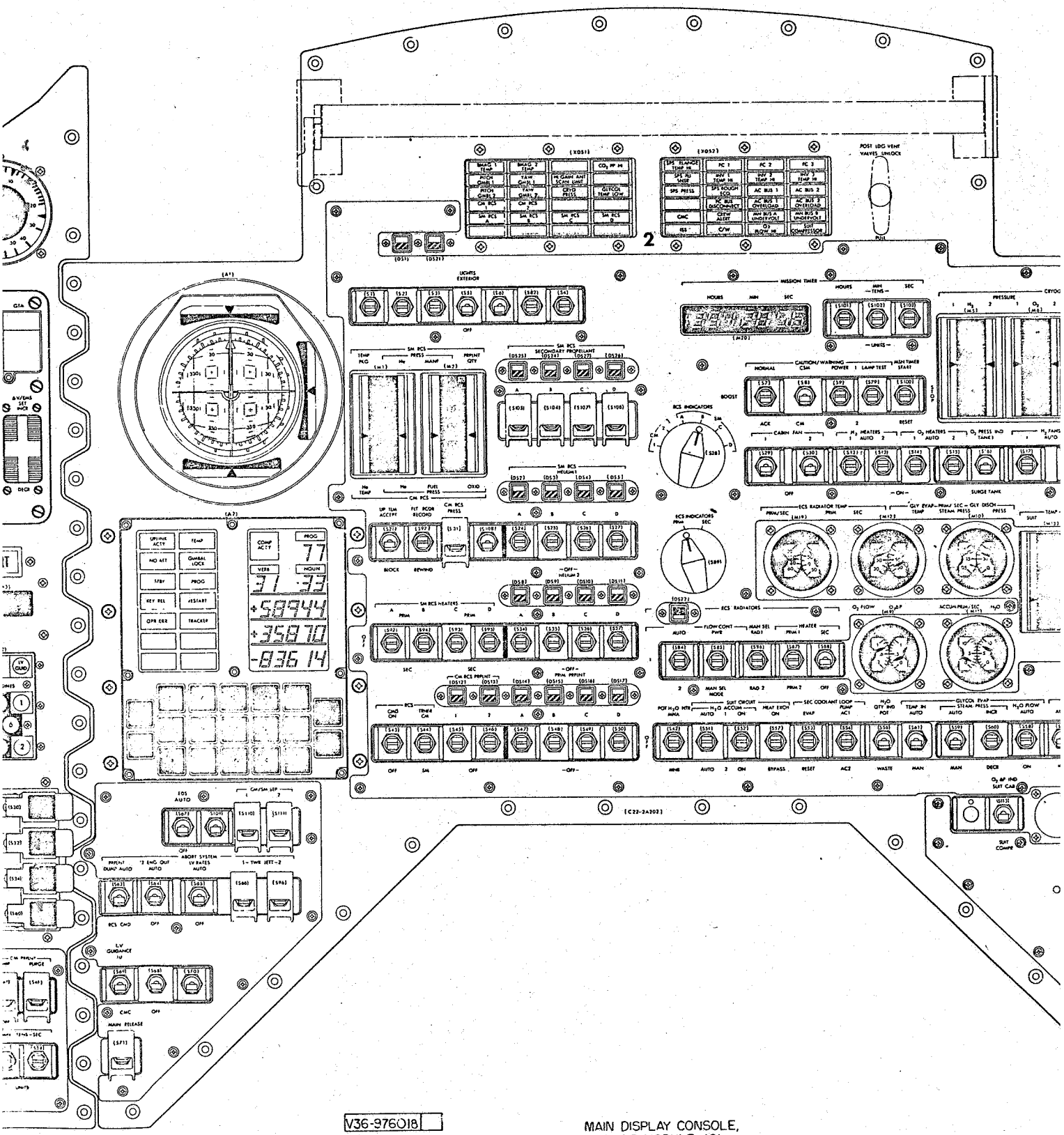

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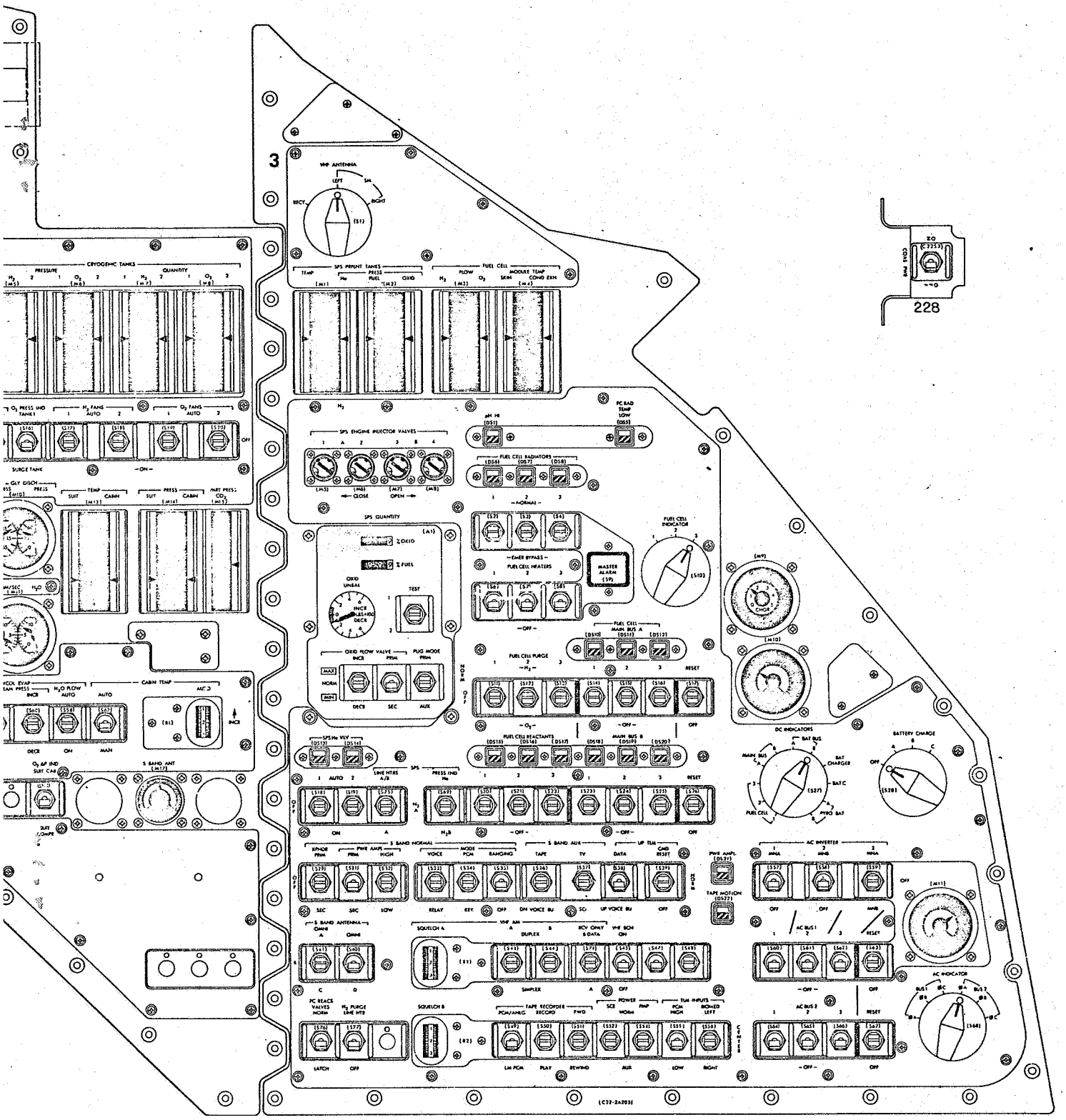
MAIN DISPLAY CONSOLE,
COMMAND MODULE 101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